

PSJ15 Exh 39

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# The Addicted Brain



**A Disease  
Perspective**

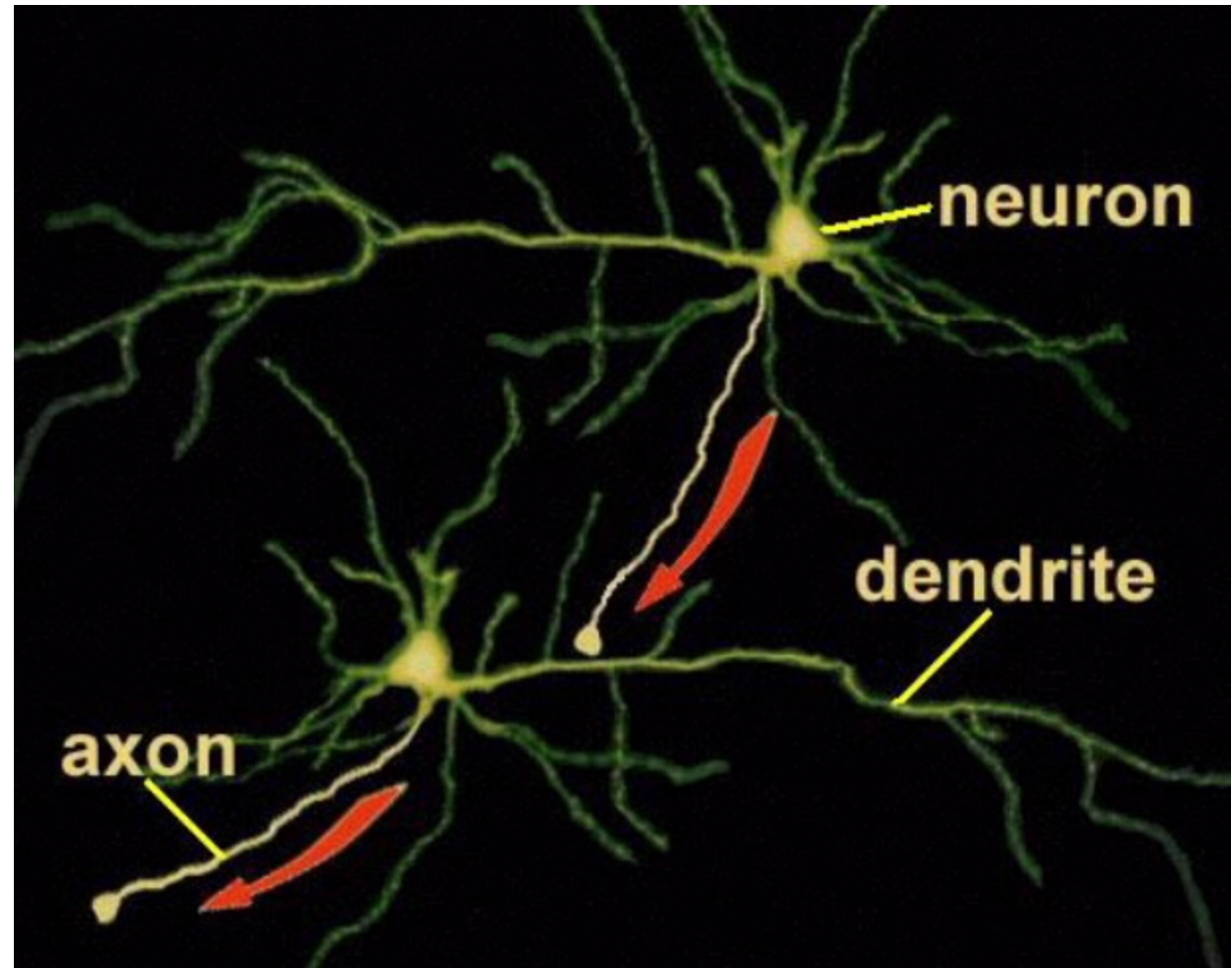
# What is this presentation about?

- Why is addiction a brain disease?
- How do addictive substances affect the brain and cause dysfunctions?
- Why do addicted persons continue to self-destruct despite reasons to stop?
- How can medications and psychotherapy help addiction recovery?

# Electro-Chemical Communication

Electrical signals in neurons travel to axon terminals.

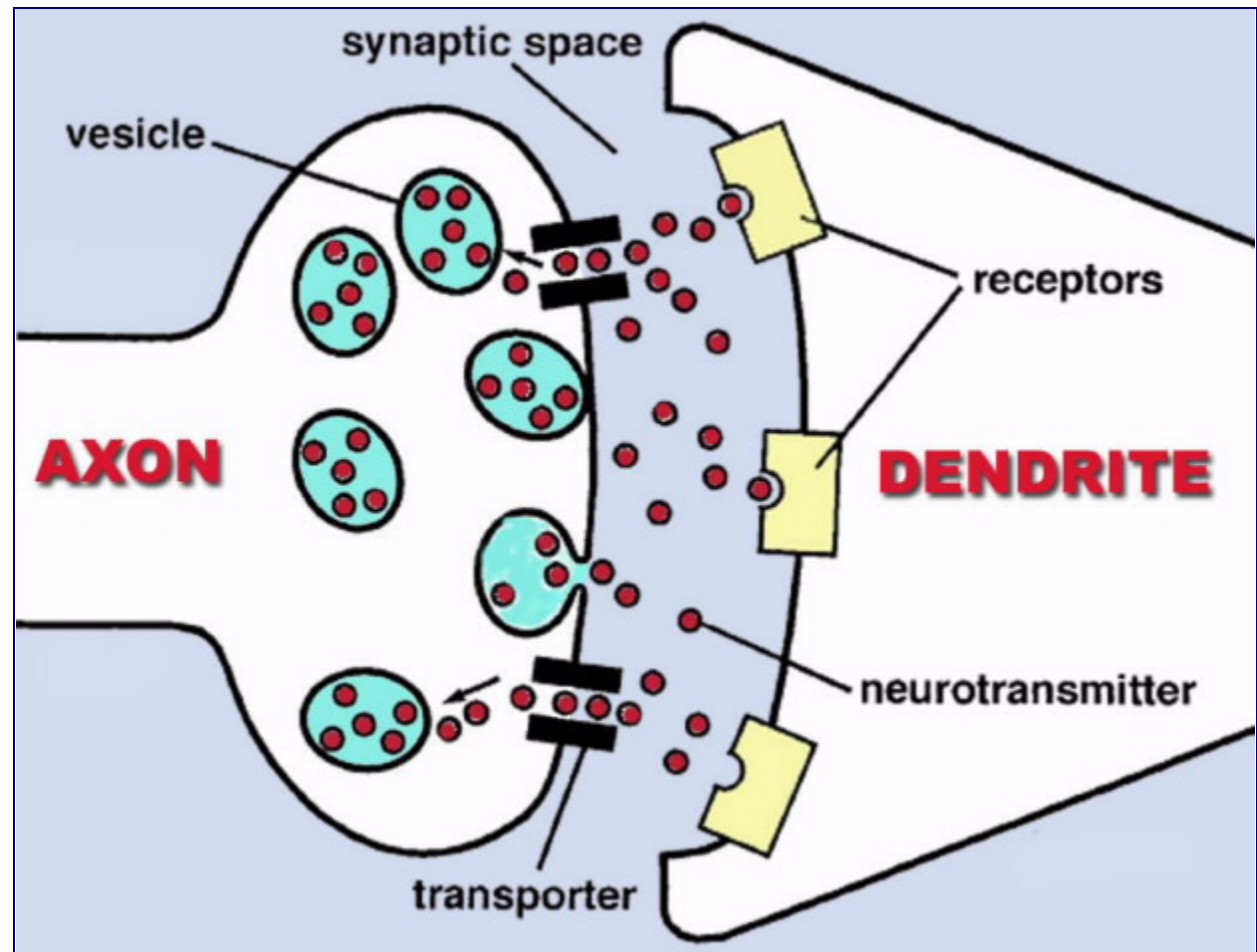
Chemicals transfer from the terminals to dendrites.



# Chemical Transfer at Synapses

Chemicals (*neurotransmitters*) cross the synapse gap to activate receptors.

Transmitters taken back into the terminal through transporters.





# Drugs Release Neurochemicals

Addictive drug  
(green molecules) crosses  
blood-brain  
barrier.

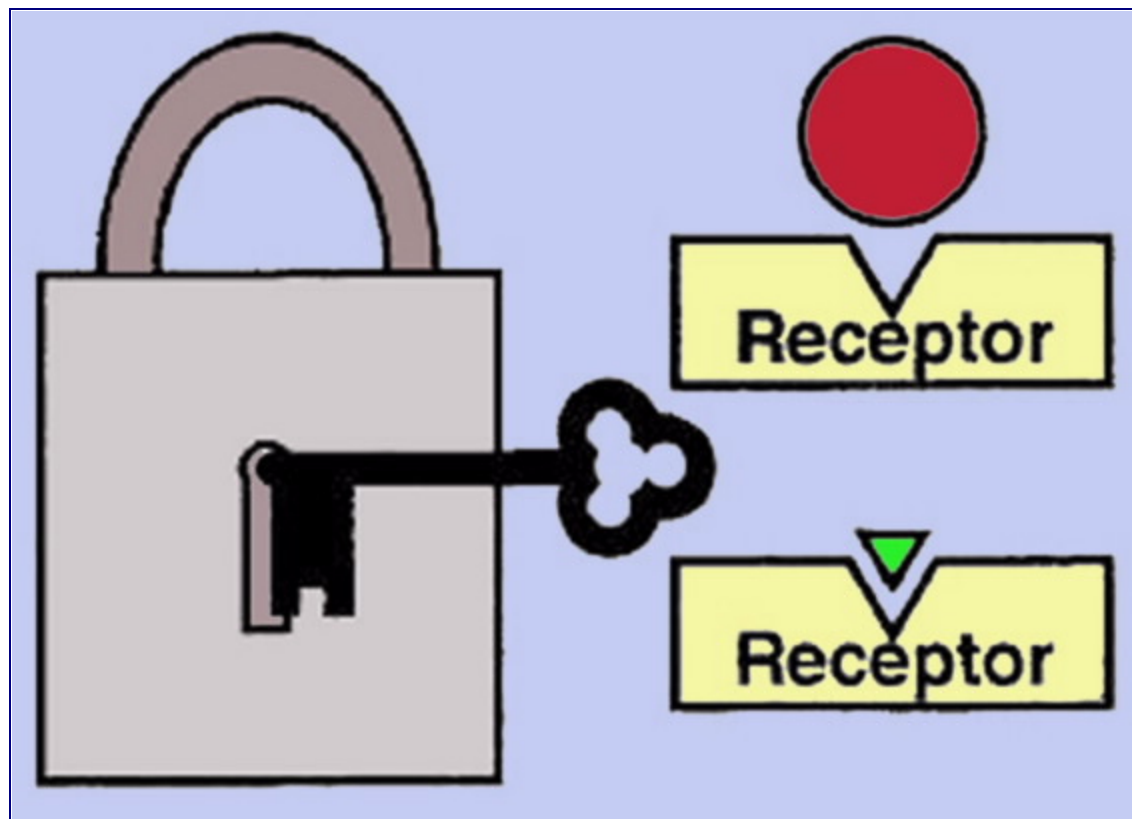
Causes flood  
of dopamine  
(white) in  
synapse.



# Drug Receptors (Lock 'n Key)

Neurotransmitters fit receptors like keys in locks.

The fit must be just right to activate the receptor.

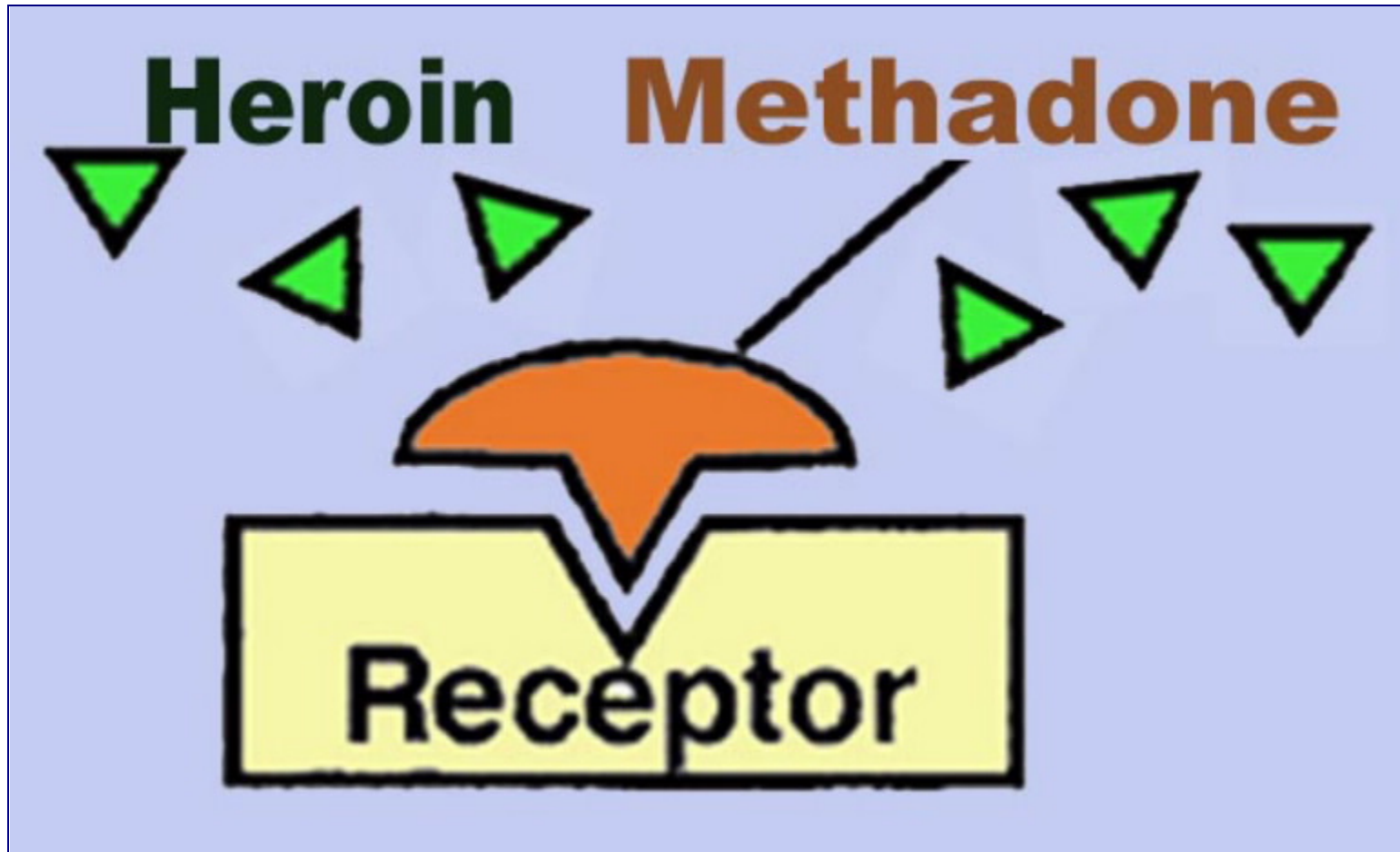


Red molecule is not a match.

Green molecule (e.g., heroin) fits and activates the receptor.

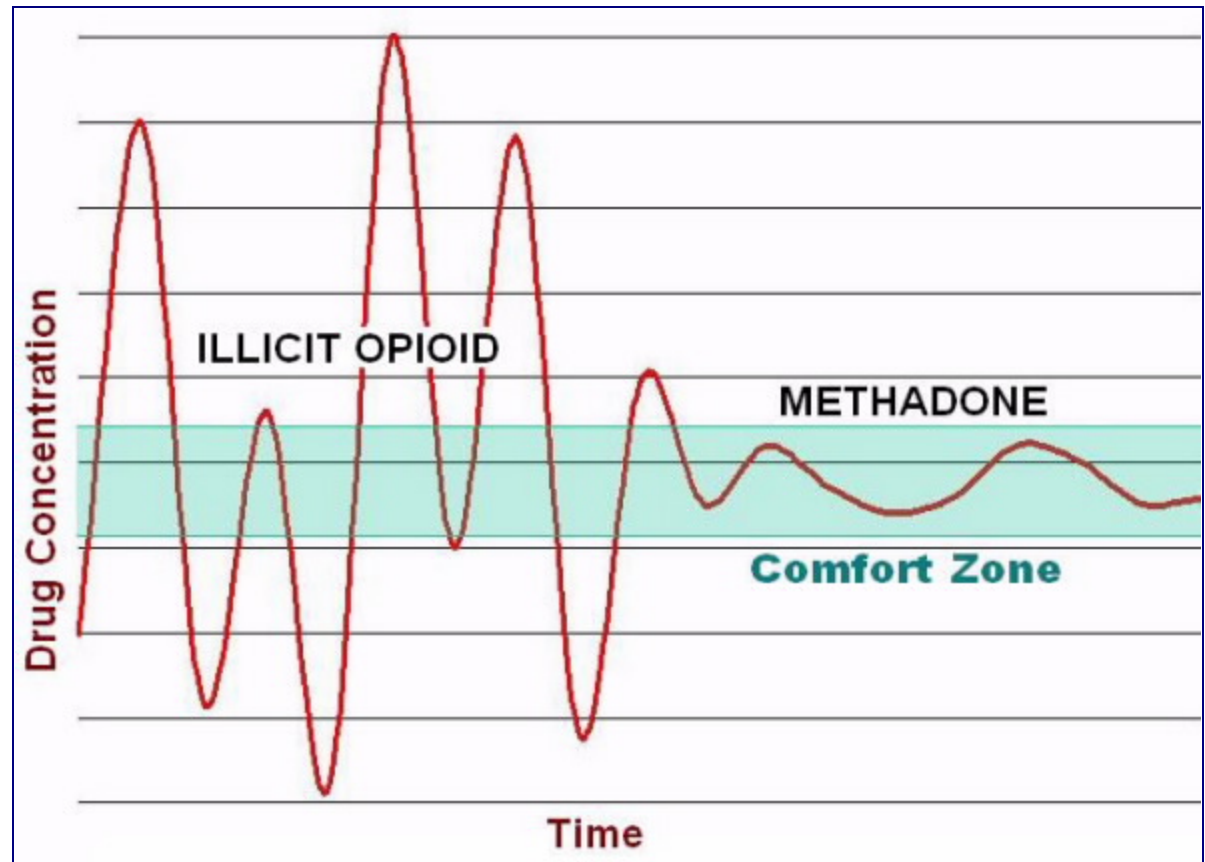


# Methadone Fills Opioid Receptors



# Taming the Roller Coaster

Methadone allows the patient to get off the opioid roller coaster and live a more normal life.



*Adequate* methadone dosing smoothes peaks and valleys. Concentration stays in comfort zone (green).



# How the Brain Became Fertile Ground for Addiction



# The Brain Evolved for Survival

It was not originally equipped to cope with video games and snack foods, or heroin and cocaine – and, it has not adapted.



The amazing thing is that more people are not addicted to more substances.



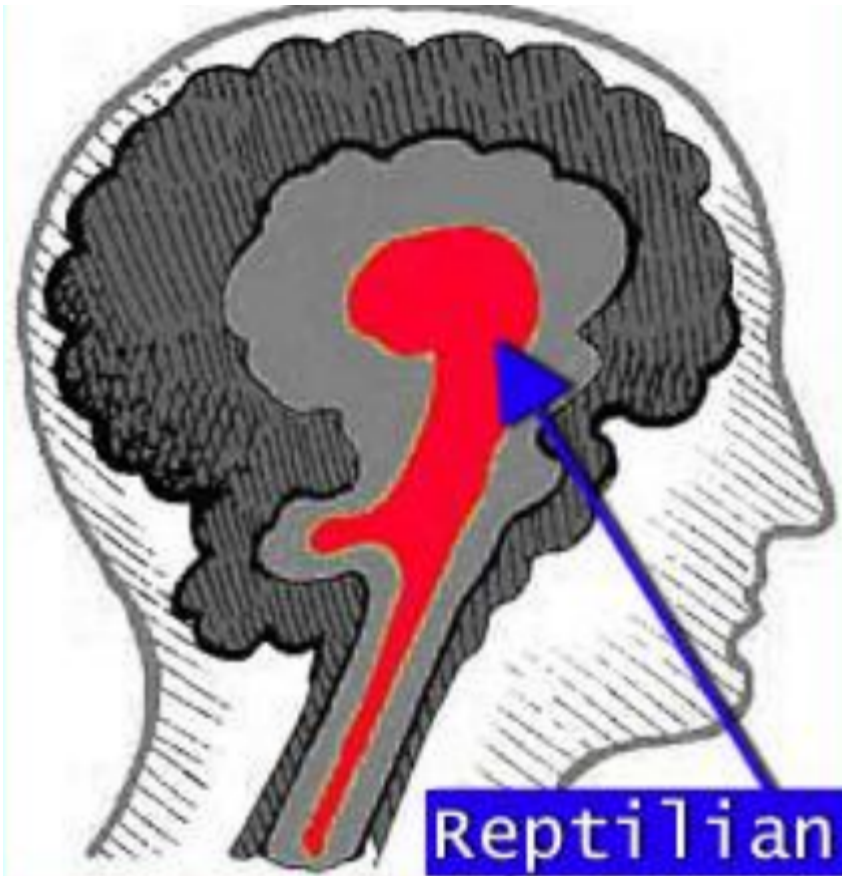
# How Brain Organization Influences Behavior & Addiction

- Brain evolved through 3 primary stages.
- Stages function together like biological computers.
- Older structures drive addiction.
- Thinking part of brain a “new innovation.”





# Primitive Reptilian Brain



- Responsible for self-preservation; instinct.
- Produces aggressive, compulsive, ritualistic behaviors.
- Repeats same behaviors without learning from past mistakes.

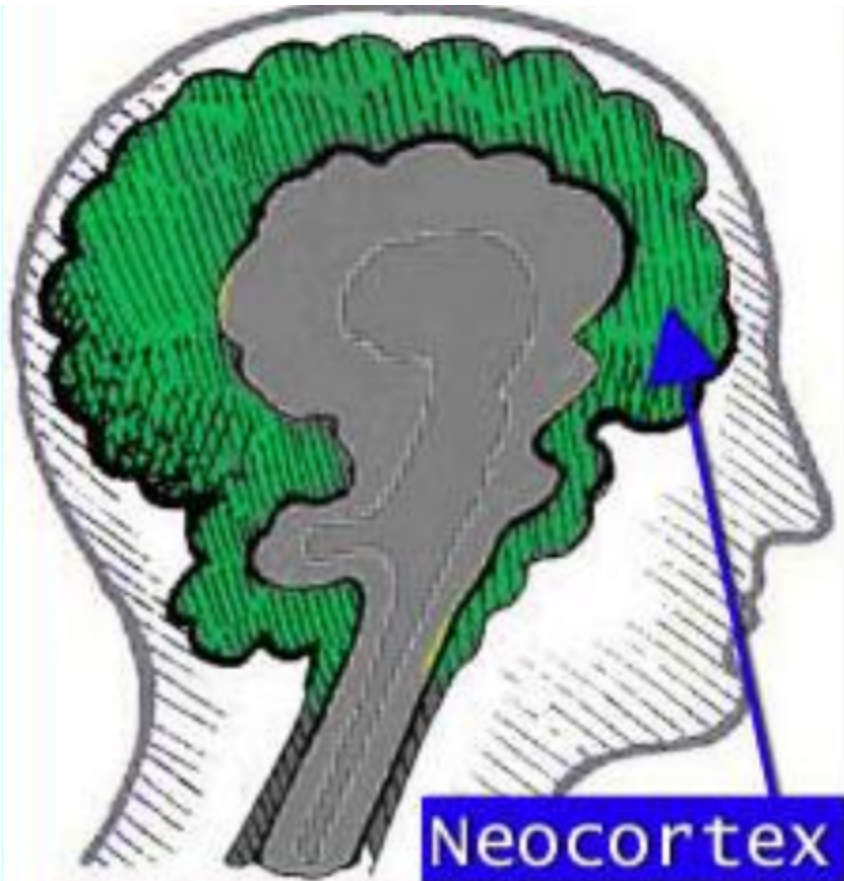
# Limbic Brain



- Older mammalian brain.
- Controls feeding, fighting, fleeing, mating.
- Drives emotions and reward-seeking.
- A center of addiction.



# Neo-mammalian Brain (Cortex)



- Higher cognitive and control functions.
- “The mother of invention and the father of abstract thought.”
- Comprises 2/3 of the brain mass in humans.

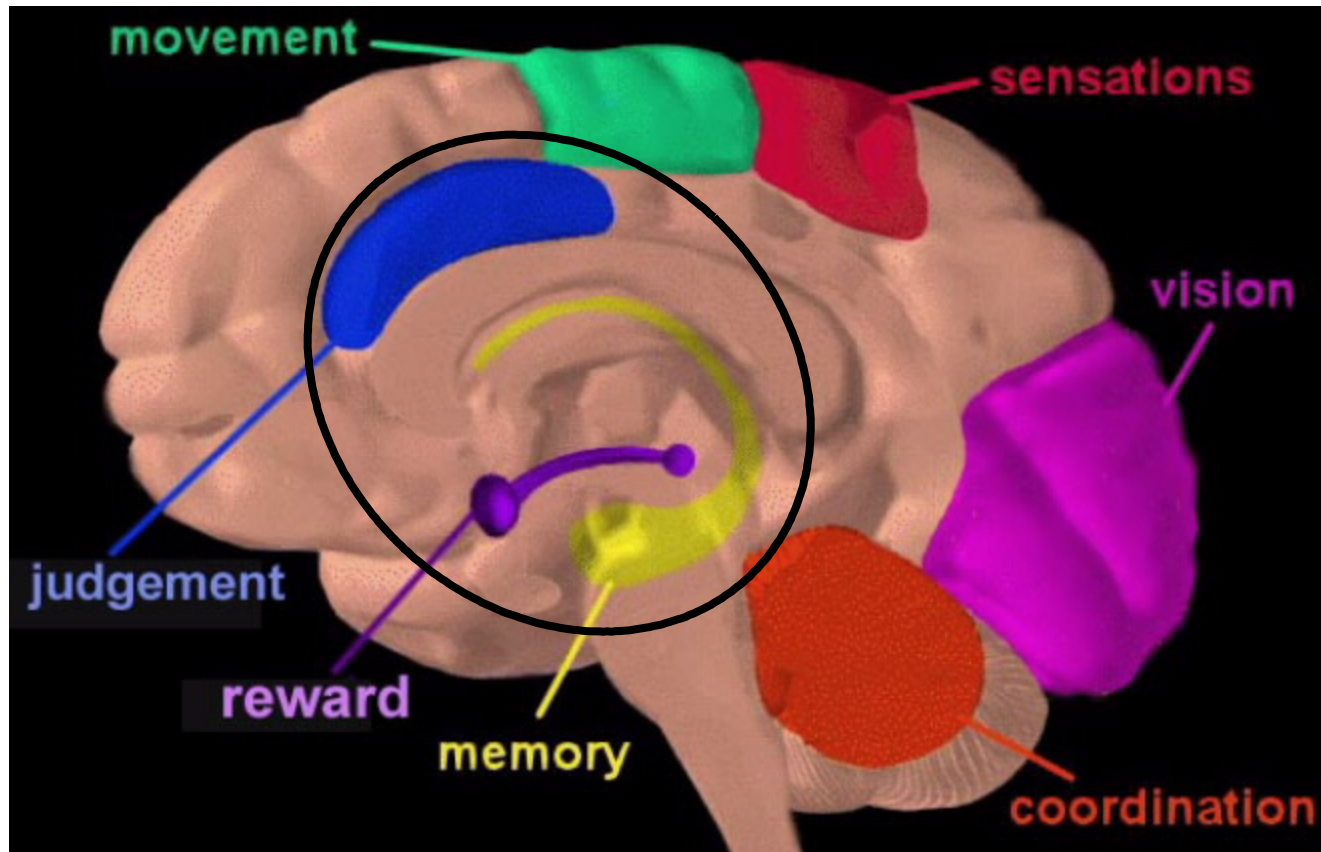


# Composite Human Brain



- Human brain has all components of brain evolution.
- “Heart” of addiction resides in more primitive structures (**red/yellow**).
- “Thinking brain” (**green**) is impaired by addiction.

# The Functional Brain



Addiction involves reward, memory, and judgement, which reside within more primitive, limbic areas of the brain (black circle).



# Dysfunctions of the Limbic Brain Are Linked to Addiction

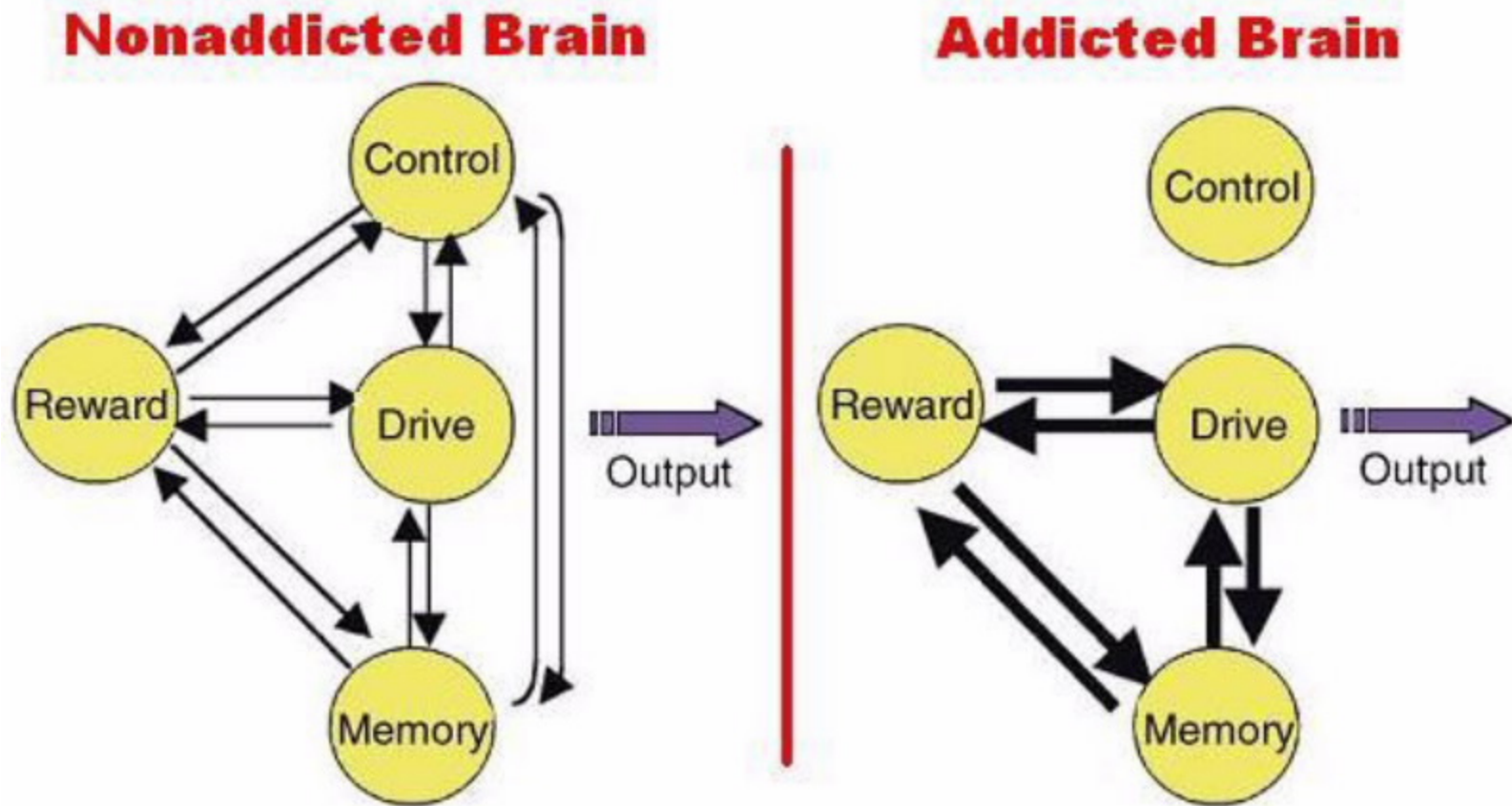
## *Limbic system disturbances promote...*

- Moodiness, irritability, depression.
- Pessimism.
- Negative emotions, de-motivation.
- Sleep problems, sexual dysfunction.
- Social isolation.



Some Limbic Structures, Mayor 2004

# The Great Disconnect



Control functions of the cortex are disconnected in the addicted brain, which becomes dominated by a dysfunctional limbic system.

# Drugs Acquire Deadly Survival Value

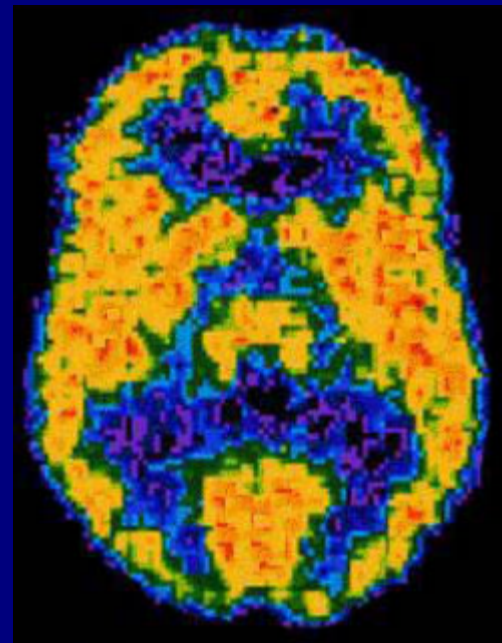
- Limbic drives take command.
- Drugs perceived as essential for survival.
- Helps explain obsessive, compulsive, self-destructive addictive behaviors.
- Recovery involves “rewiring” the brain for a sober life.





# Addictive Drugs Alter Brain Structure & Function

The result is a  
neurobiological  
*disease* state.





# Shrinking Neurons

Opioid addiction shrinks dopamine neurons in reward centers.

*(Box)*

Dendrites wither, filaments in axons reduced.

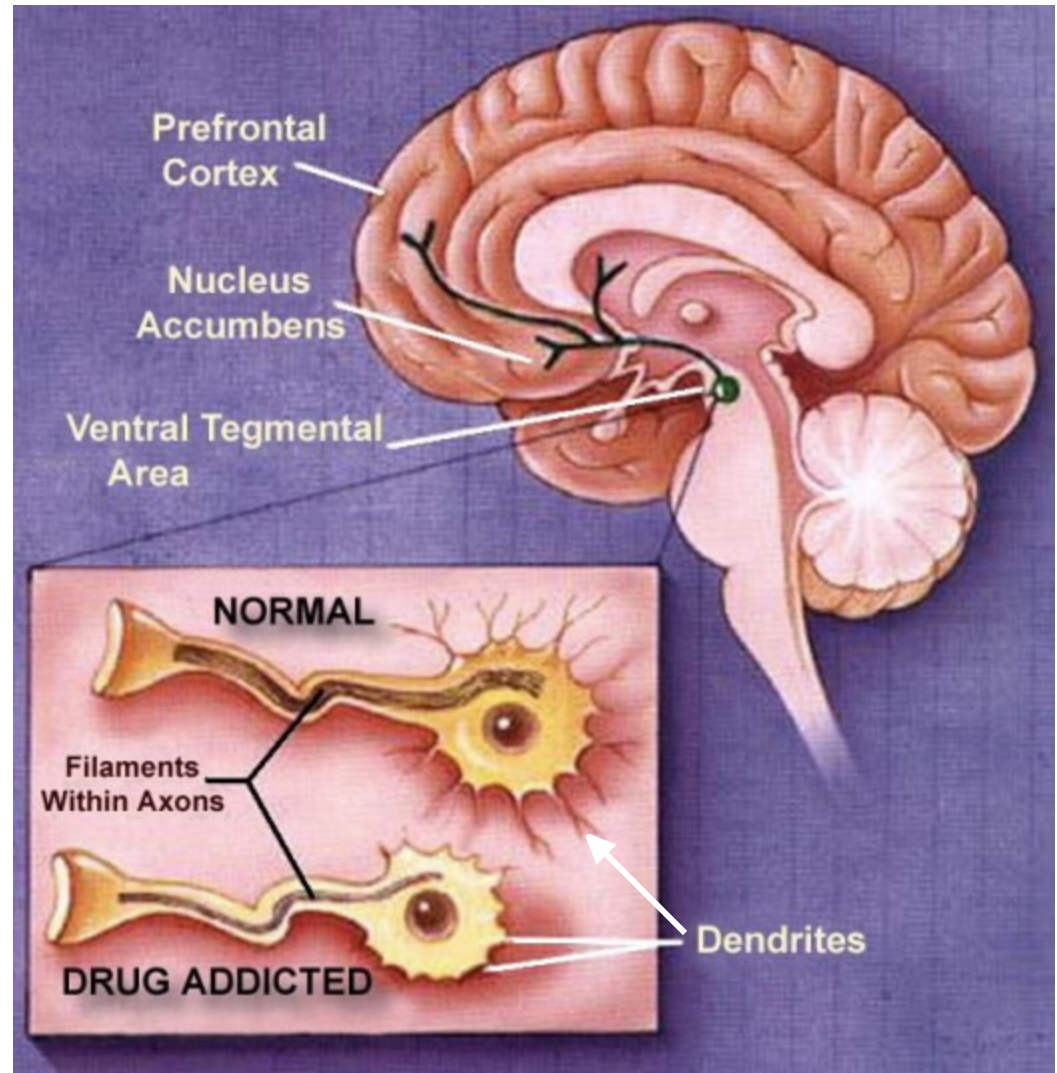
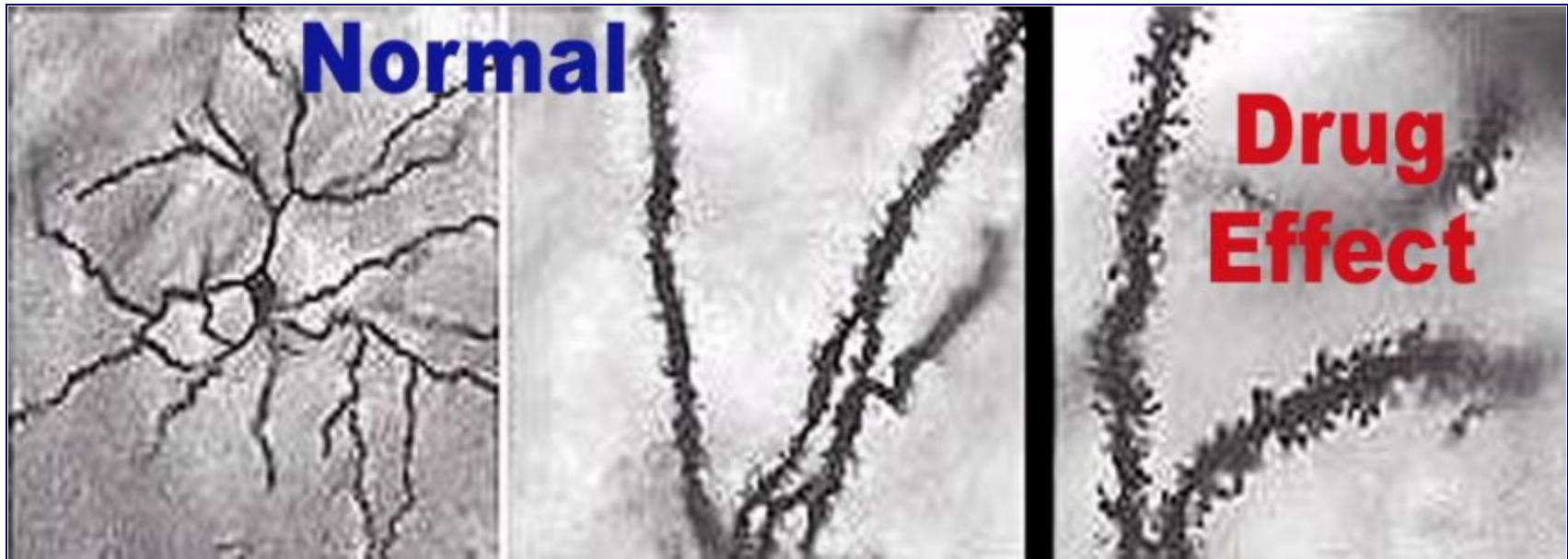


Illustration modified from L. Kibiuk, in Ariniello 1997



# Abnormal “Hairy” Dendrites

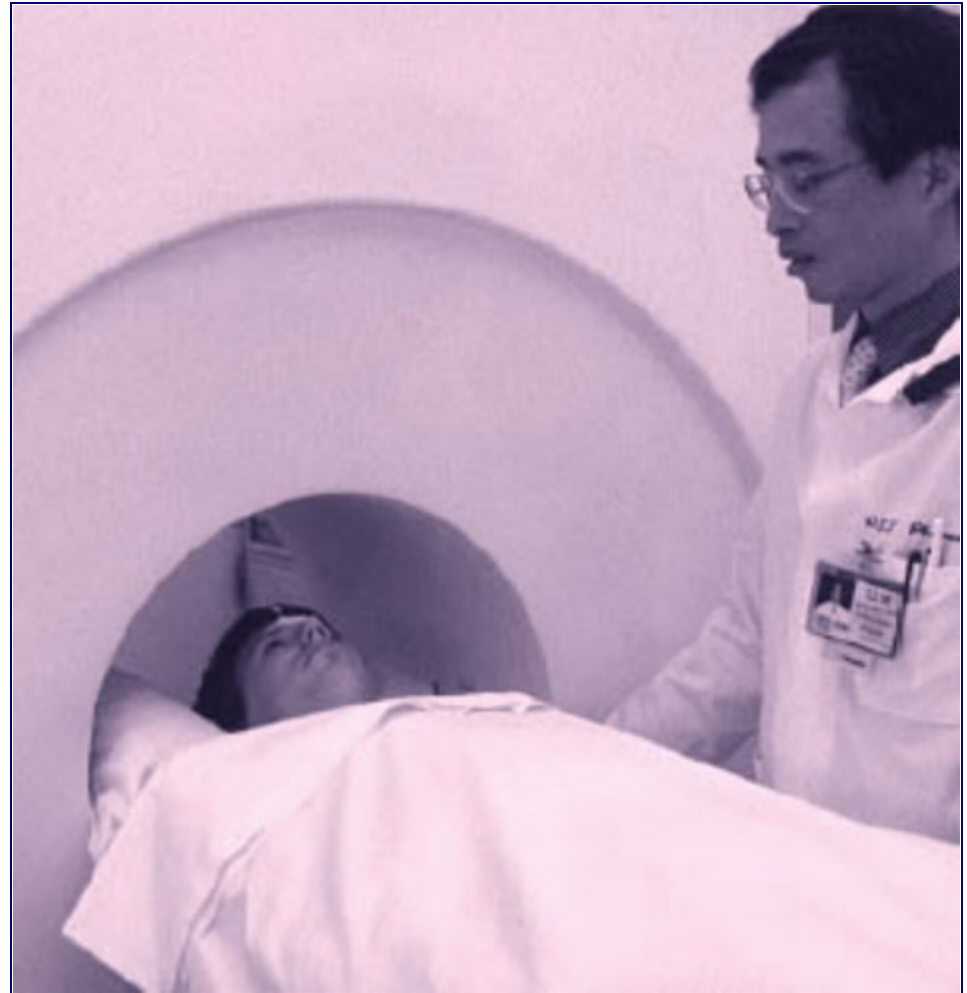


Addictive drugs cause dendrites to vastly increase the number of signal-receiving projections (spines) on their branches (micrograph on right).

# PET Scanning: Peering Into Brain Function

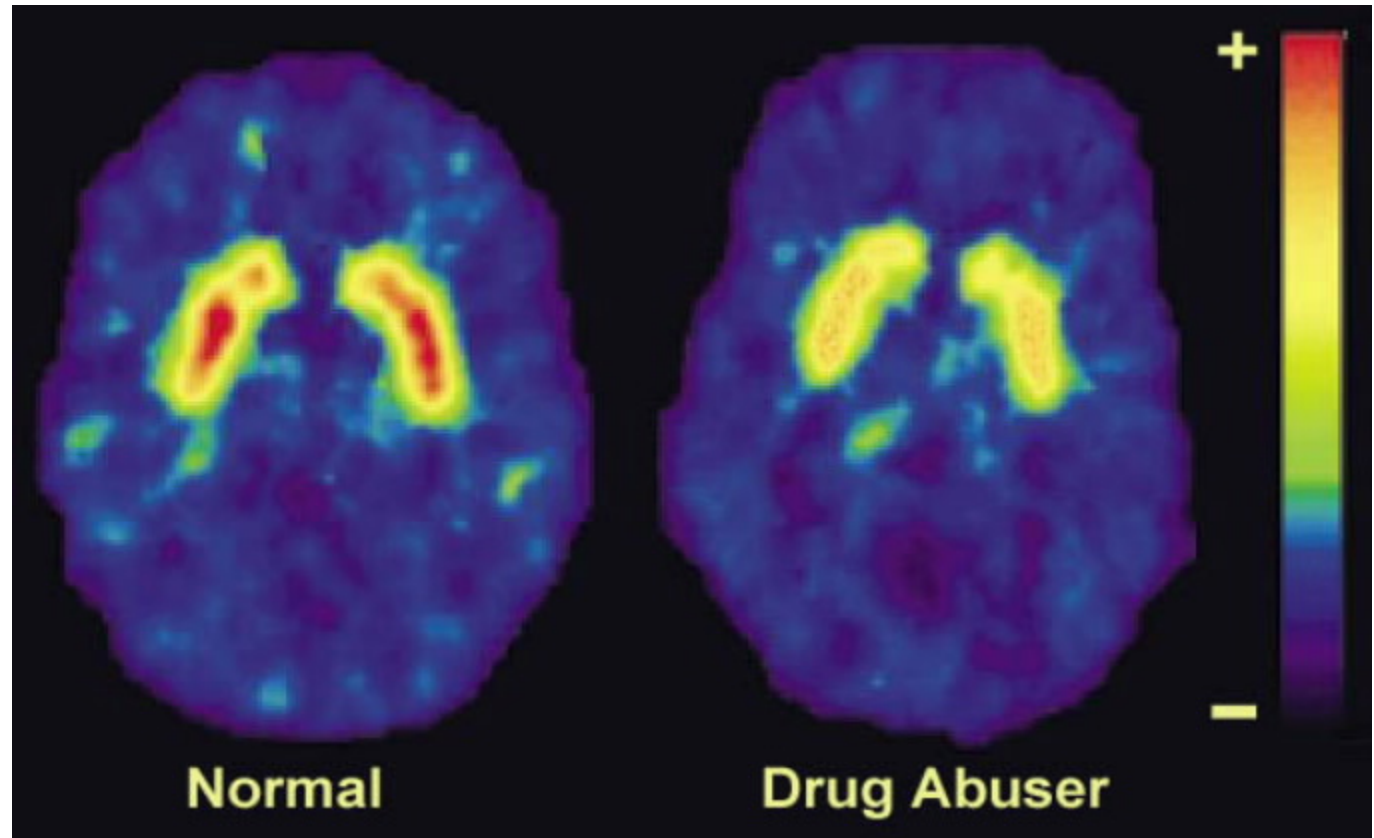
Positron emission tomography (PET) measures activity in specific regions or neurons in the brain.

Patients are awake during image scanning, which is painless



# The Drugged Brain: PET Scans

Chronic  
drug abuse  
decreases  
dopamine  
in reward  
pathways.

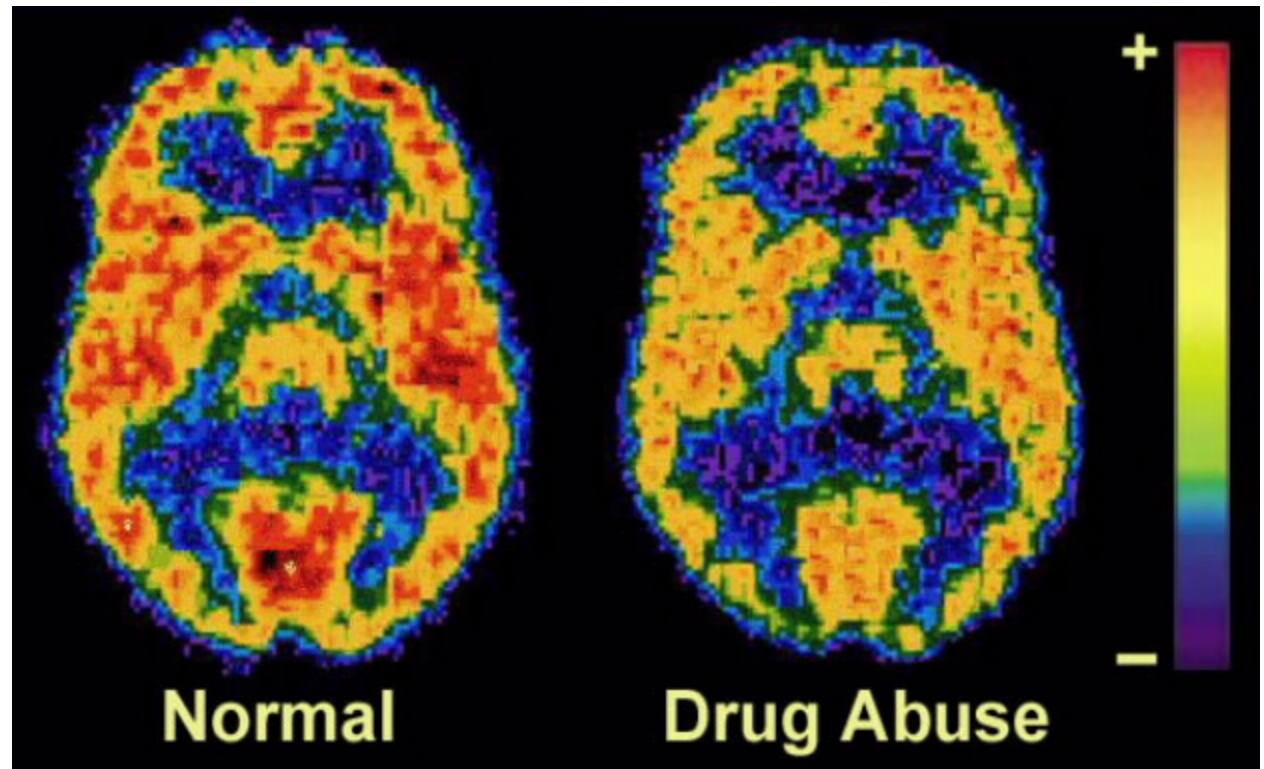


Left: red areas show normal dopamine activity.  
Right: chronic drug abuse effects.

# Illicit Drugs Can Decrease Normal Brain Activity, Disrupt Function

Chronic drug abuse reduces glucose metabolism.

Lowered activity disrupts many brain functions.



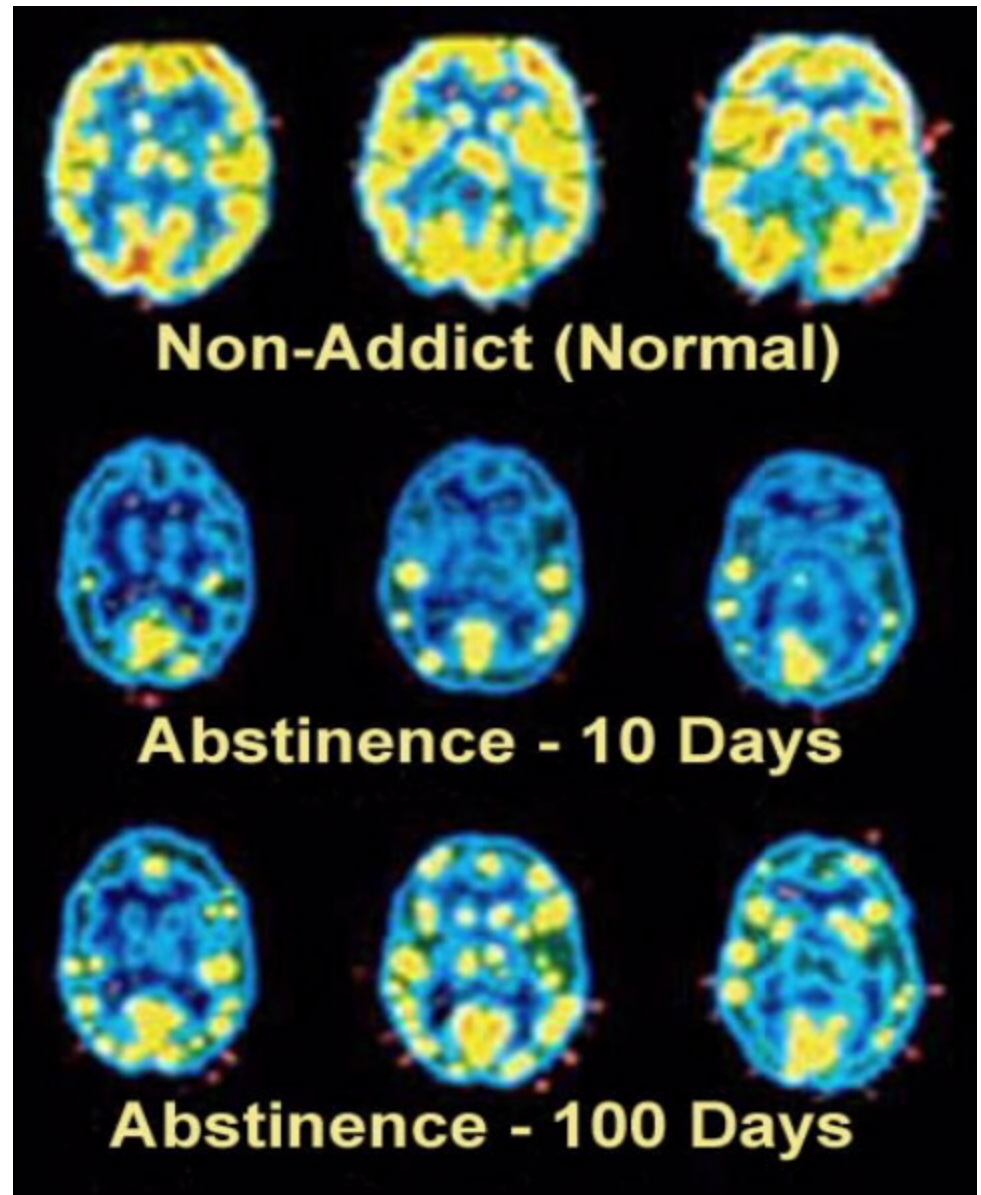
Left: red depicts normal glucose use.  
Right: activity greatly diminished.



# Drug Effects Are Persistent

Dysfunction can persist long after the last dose of a drug or alcohol is taken.

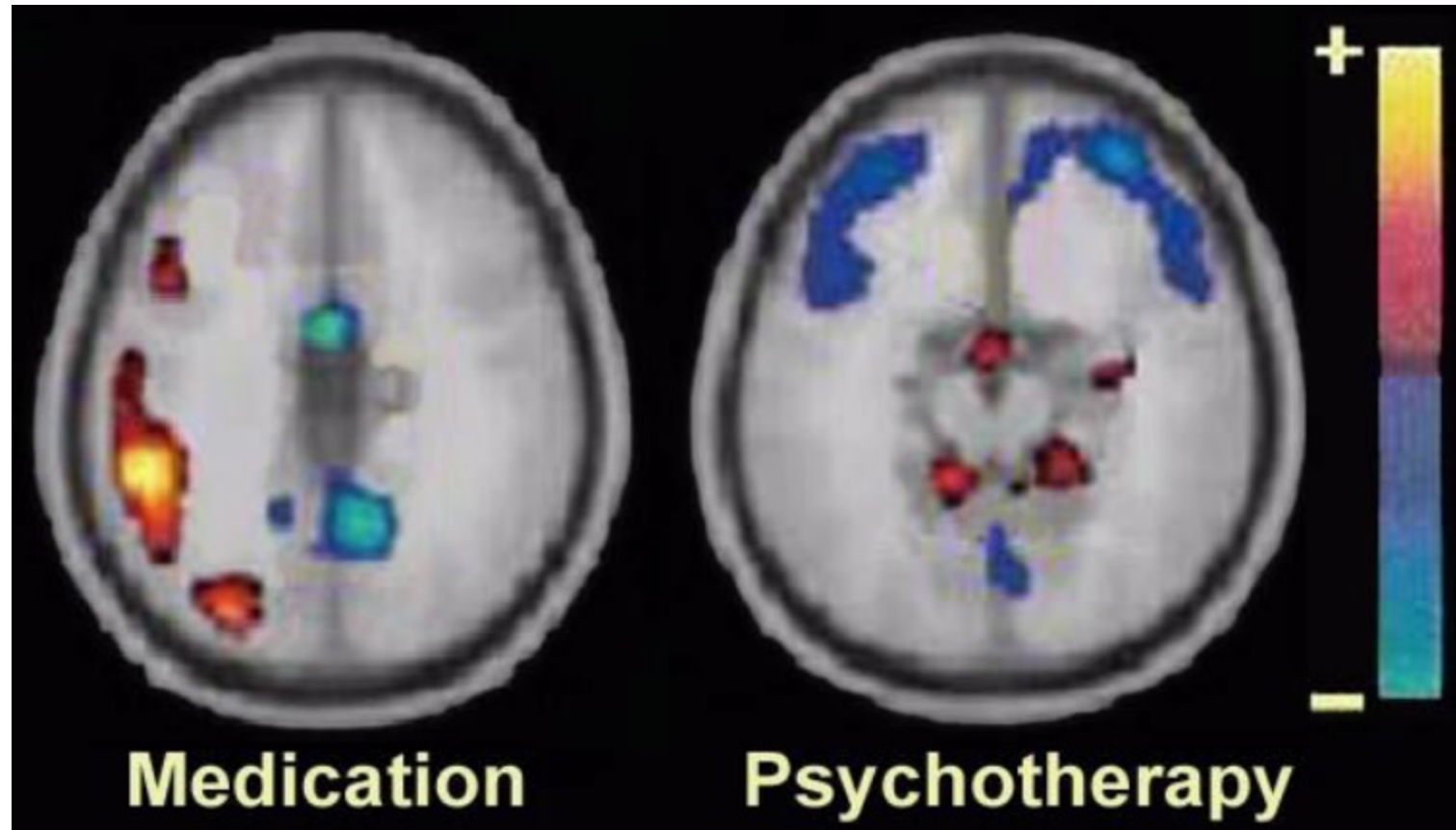
Brain shows decreased cerebral cortex activity for several months or much longer.



PET scans modified from Brookhaven National Laboratory



# Medication vs Psychotherapy



Meds and psychotherapy both benefit brain function.  
Each may affect different parts of the brain in opposite ways.

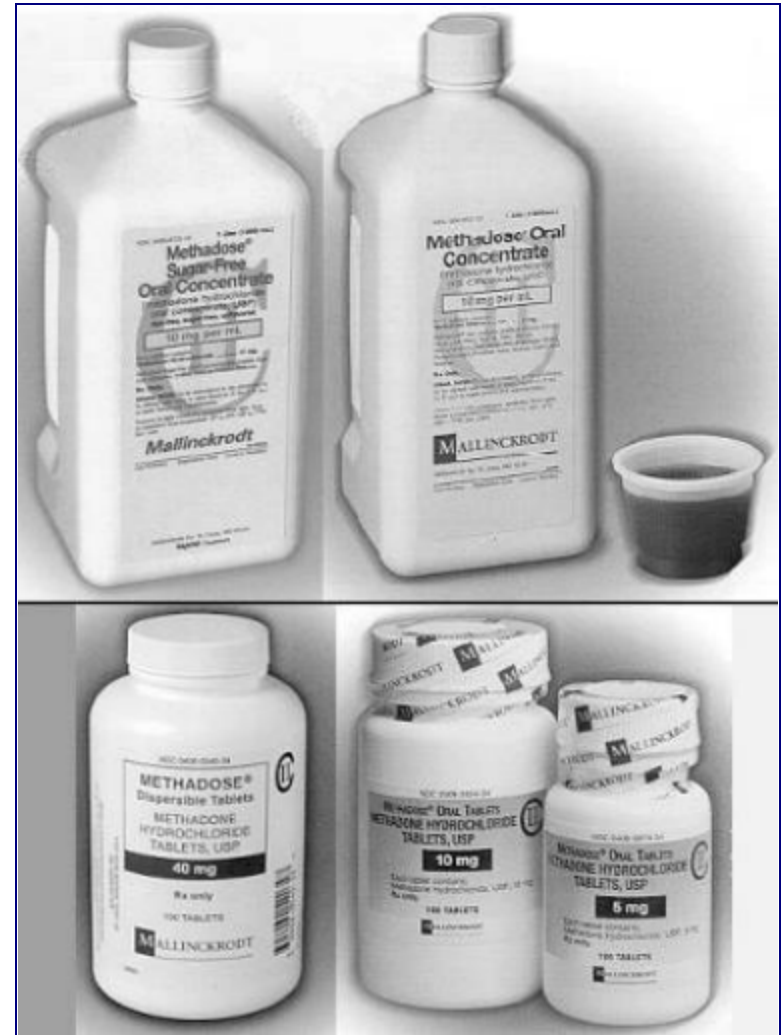
# Treating Addiction

- No “magic bullets.”
- No “cure” for addiction.
- Time required for return to more normal brain function is unknown.
- Ongoing therapy may be required for a lifetime in recovery.



# Methadose® Brand of Methadone HCl from Mallinckrodt

- Helping to meet the need for flexibility in dosing.
- 5 formulations:
  - Liquid...
    - Cherry (10 mg/mL).
    - Sugar-free, dye-free, unflavored (10 mg/mL).
  - Solid
    - Tablet - 5 mg or 10 mg
    - Dispersible Tab - 40 mg.





# Conclusions

- Addiction is a multifaceted disease.
- Chronic drug abuse creates serious dysfunctions in brain activity.
- Judgement and control functions are disconnected; patients cannot simply *think* their way out of addiction.
- A combination of medication (such as, methadone) and psychotherapy may be required for a lifetime.